CHARACTERISTICS AND MANAGEMENT OF TIDAL IMPOUNDMENTS FOR WILDLIFE IN A SOUTH CAROLINA ESTUARY

by

PATRICK H. MORGAN
Institute of Natural Resources, 203 Forest Resources Building
University of Georgia, Athens 30602[1]

A. SYDNEY JOHNSON
Institute of Natural Resources, 203 Forest Resources Building
University of Georgia, Athens 30602

WILLIAM P. BALDWIN
Land Management Consultant
Box 818, Summerville, S. C. 29483

J. LARRY LANDERS
School of Forest Resources, 203 Forest Resources Building
University of Georgia, Athens 30602

ABSTRACT

The characteristics, management and costs of 213 diked impoundments in an important waterfowl wintering area in coastal South Carolina were studied in 1972-73 by intensive field surveys and interviews with owners, managers, construction companies, and tax collectors. Managed impoundments composed 22,536 acres of the total 98,451 acres of marshland and were claimed by 52 individuals or private groups and two state agencies. The objectives in management varied, but attracting waterfowl or snipe was an objective for 77 percent of the impoundments composing 87 percent (19,617 acres) of the total acreage of managed wetlands. Waterfowl food production was achieved primarily by manipulating natural vegetation through control of water levels and salinities, often in coordination with cattle grazing. Specific techniques of vegetation control are described, and dimensions and descriptions of dikes and water control structures are given. Harvest was estimated to be 11,438 ducks for the 1972-73 season, averaging 3.3 ducks per man-day and 0.6 ducks per acre of impoundment managed for waterfowl. Total capital value of dikes and water control structures was estimated at $2,048,774. Capital investments annualized at 8 percent for 20 years and management costs directly attributable to the maintenance and management of impoundments amounted to $27.06 per acre per year or $530,836 for all impoundments in the study area managed for wildlife. Costs of hunting were estimated to be $150 per man-day and $45 per duck harvested.

INTRODUCTION

A study of certain biological and economic aspects of wetland management in a South Carolina estuary formed by three rivers — South Edisto, Ashepoo and Combahee — was conducted in 1972-73. The general purpose was to survey, describe and analyze the management of wetlands in an important waterfowl wintering area with large acreages of diked marsh and to relate the resulting data to South Carolina coastal zone management policies. In this paper we describe the management of diked impoundments on public and private properties for attracting migratory game birds.

The study area, centered 45 miles southeast of Charleston, South Carolina, lies within Charleston, Colleton and Beaufort counties (Fig. 1). The Edisto-Ashepoo-Combahee drainage system is one of seven major drainage systems on the South Carolina coast.

An important feature of these estuaries is the diked impoundments, mostly remnants of a system of intensive rice culture developed during the 17th to 19th centuries when South Carolina produced 70 percent of the total rice crop of the United States (Doar 1936).

Rice was grown under two systems: dry culture and wet culture. Dry culture was practiced before irrigation was developed or on lands not suitable for irrigation. Wet culture was practiced on three types of areas: (1) freshwater tidelands, (2) river swamps above mean high tide but susceptible to irrigation by canals conducting waters from the river above the fields and returning it below, and (3) creek bottoms which could be irrigated from reservoirs impounded above the fields. Rice culture was practiced most efficiently in the tidelands (McLendon et al. 1914).

Inland swamps were first cleared for rice fields, and later freshwater tidal swamps were cleared. Both types of swamps were heavily timbered, predominantly with gum (*Nyssa* spp.) and cypress (*Taxodium* spp.). The rice field dikes and ditches in the inland swamps have been overgrown for many years, and, though readily noted during field inspection, were not easily discernible from aerial photographs at a scale of 1:20,000. Rice field complexes in the tidal areas, however, are easily distinguished on aerial photographs (Fig. 2).

[1] Present address: South Carolina Wildlife and Marine Resources Department, Route 2, Box 182, Georgetown 29440.

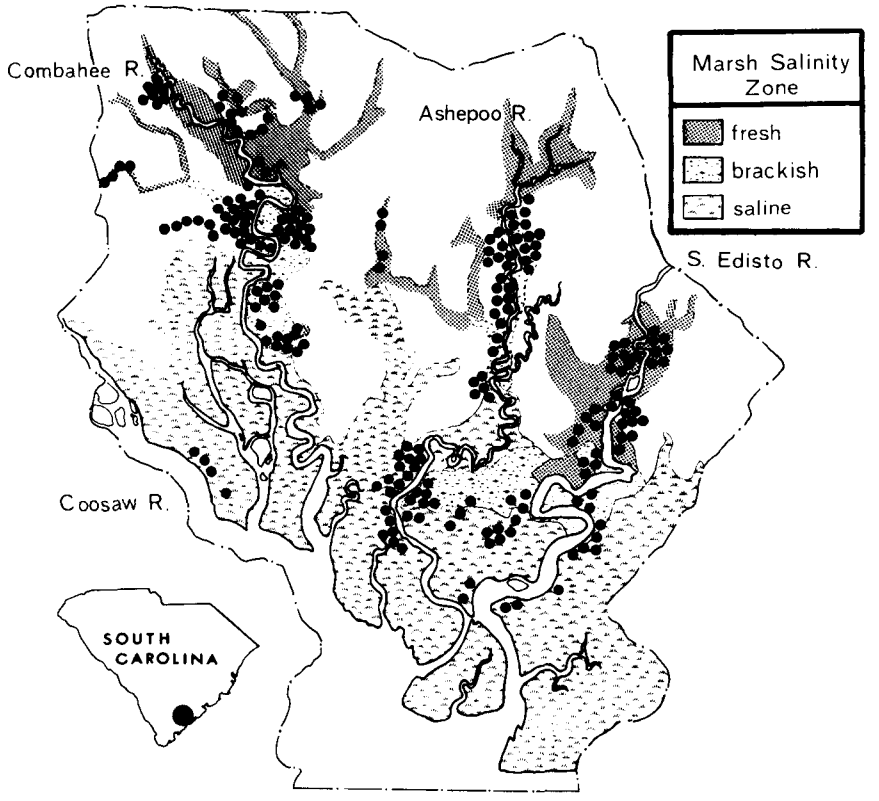

Fig. 1. Map of the South Edisto-Ashepoo-Combahee River System showing salinity zones and approximate locations of 213 impoundments, 1972.

Fig. 2. Aerial photograph of an area on the Combahee River showing former rice fields: (A) maintained, (B) not maintained.

Doar (1936) reported 20,856 acres of planted rice fields for the three rivers of the study area between 1850 and 1860. Rice culture seriously declined after 1865 with the loss of slave labor and increased competition from rice growers in Louisiana, Texas and Arkansas, where conditions allowed the use of machinery. Hurricanes of 1893 and subsequent years caused extensive damage to rice fields of the Combahee and South Edisto rivers and brought to an end commercial rice culture in South Carolina. Some of the plantations were purchased by wealthy individuals who repaired and maintained dikes and water control structures to develop duck-shooting areas. The new owners developed techniques of water control for growing duck foods, and many of the impoundments remain under such management today, attracting large numbers of wintering waterfowl. During 1964-1973, an average of 114,000 ducks were estimated in the study area each year during the U. S. Fish and Wildlife Service Midwinter Waterfowl Surveys.

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METHODS

Aerial photographs (scale 1:20,000) were used to locate all wetlands in the study area. The aerial photographs were taken over Charleston, Colleton and Beaufort counties in 1963, 1968 and 1965, respectively, and were obtained from the ASCS-USDA, Eastern Aerial Photography Laboratory, Asheville, N. C. Areas diked too recently to be shown on aerial photographs were located during field surveys and interviews. It is unlikely that any impoundments were overlooked.

Intensive field work was conducted from June 1972 through March 1973. Landowners were sent an introductory letter explaining the study and asking for their cooperation. Then, by appointment, visits were made to each property.

During the survey of a property, discussions were held with the owners or managers or both concerning management objectives, procedures, problems, waterfowl species and numbers attracted, and secondary uses of each impoundment. For dikes and water control structures, age, construction and maintenance cost, date last reworked, and condition were recorded when known.

Each dike and impoundment was examined, delineated on aerial photographs and assigned an identifying number (impoundments) or letter (dikes). Specific information for each impoundment and each dike was recorded on specially prepared data sheets. With the aid of binoculars, aerial photographs, and a small boat, the impoundments were surveyed for composition of vegetation, water salinity, and depth. Plant species were identified and an estimate of the percentage of the total impounded area occupied by each important species was recorded.

Each water control structure was measured, and its dimensions were recorded along with the type of material with which it was constructed, the number of flap gates and flash-board risers, and other details. Top widths of dikes were measured by pacing; heights and bottom widths were estimated. Later, areas of all impoundments and lengths of all dikes were measured from aerial photographs.

One landowner would not permit entrance to his property; his marsh impoundments were examined from aerial photographs, airplanes, navigable rivers and creeks, and public roads that passed through the property.

Owners of dike-construction companies and persons constructing and installing water control structures were interviewed to obtain information on costs of construction and maintenance. Tax assessors of each county were interviewed to obtain assessment values and ratios and millage rates for estimating taxes paid on wetlands in 1973. The property plats and aerial photographs at each county seat were examined to locate any unclaimed, and therefore untaxed, wetlands in the study area.

Lengthy questionnaires were sent to a representative sample (44 percent) of the marsh owners in the study area. These questionnaires requested confidential information on capital investments, cost of maintenance and habitat management, income from marshes, taxes paid, management techniques, harvest and yield data, waterfowl populations, and opinions concerning legal restrictions on the use of privately claimed marsh.

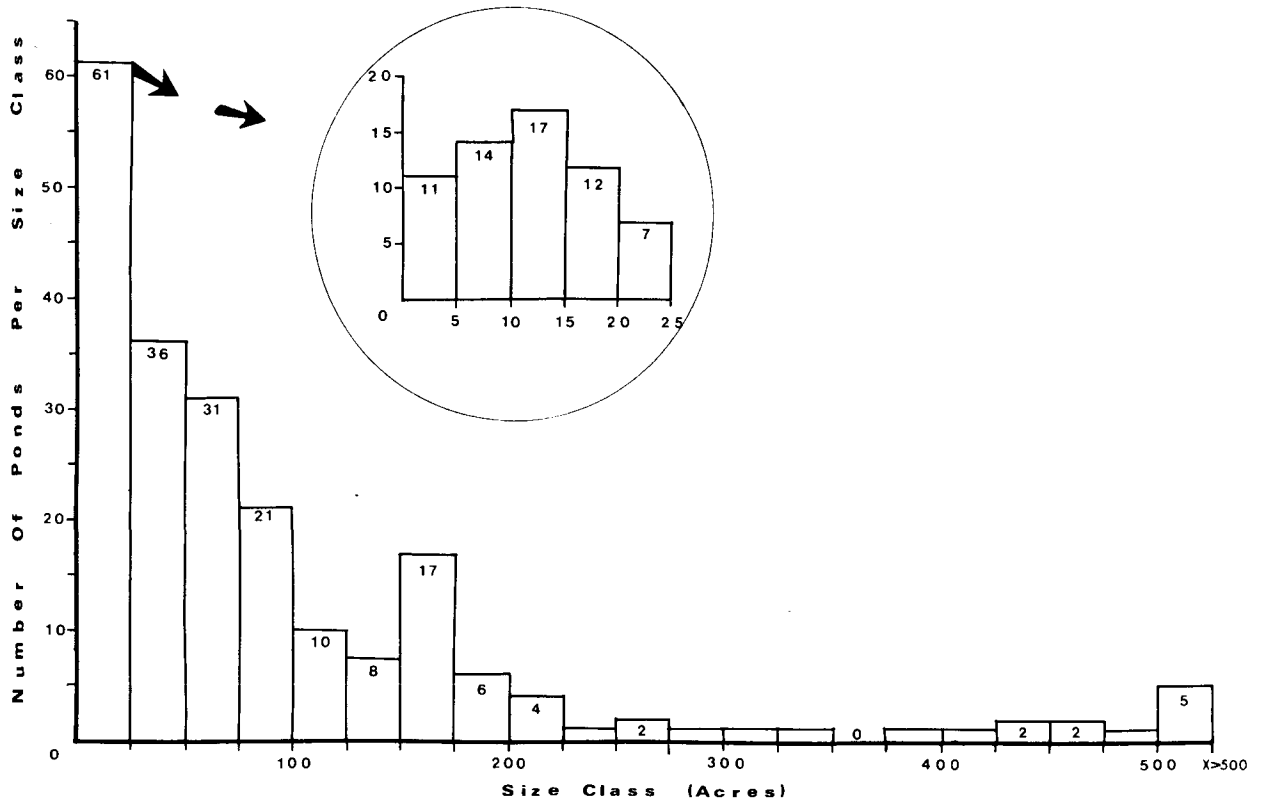

Fig. 3. Size distribution of 213 managed impoundments on the South Edisto-Ashepoo-Combahee River System, 1972.

RESULTS AND DISCUSSION

The boundaries of the study area encompassed 98,451 acres of wetlands, consisting of undiked tidelands, managed and abandoned rice fields, and managed and abandoned impoundments constructed since the era of rice culture. Diked impoundments included 22,536 acres under water control (12,248 acres of fresh marsh and 10,288 acres of brackish marsh) and 21,828 acres of abandoned diked areas.

Most of these wetlands (92,346 acres), including undiked tidal marsh, were claimed by 52 private landowners. Two areas encompassing 4,339 acres of wetlands were owned and managed by state agencies, and another 1,766 acres were not accounted for in the tax records. Private claims to ownership of many of these wetlands have been disputed by the state of South Carolina (Latimer 1968, 1972; Cheshire 1971; Leavell 1971; Baldwin 1972; Middleton 1975). Privately claimed wetlands were generally parts of estates on adjoining high ground, managed for cattle, timber and game, and ranging in size from 780 to 6,218 acres and averaging 2,979 acres.

There were 213 water-controlling impoundments concentrated along the rivers in the fresh and brackish zones (Fig. 1). They ranged in size up to 1,546 acres (Fig. 3); 69 percent were rediked former rice fields. Of 37,070 acres determined to have been under water control during the era of rice culture, 61 percent was under water control in 1972.

Owner Objectives

Attracting ducks was a primary objective on 154 (72 percent) of the managed impoundments and on 19,064 acres (84.6 percent) of the total wetlands under management. Dabbling ducks (subfamily Anatinae) were desired, but ring-necked ducks (*Anas collaris*, subfamily Nyrocinae) also were abundant and frequently shot over permanently flooded ponds vegetated with water-shield (*Brasenia schreberi*) and white waterlily (*Nymphaea odorata*).

The second most common objective in management was cattle grazing. Cattle grazed in 22 diked areas composing 2,461 acres on eight properties. Grazing commonly was coordinated with management for waterfowl or snipe or both.

Snipe (*Capella gallinago*) shooting was an objective for 11 ponds composing 553 acres on five properties. It was commonly a co-objective with attracting waterfowl and cattle grazing or both and was also an incidental use of some impoundments.

Among the less frequent objectives were water storage, fishing, growing cypress trees, wildlife sanctuaries, aesthetics and beautification, spoil disposal, and shrimp and oyster culture.

Dikes and Water Control Stuctures

Waters were impounded by earthen dams or dikes built by dike-construction companies using dredging machinery (drag-lines). The soils that formed the finished dike came from a "borrow-pit" dredged on the inside of a pond. This borrow-pit, after pond construction, formed a permanent deep canal. Normally, two trips of the drag-line around the area to be impounded were necessary to construct a dike.

There were 157 miles of dikes forming the impoundments. The range in top widths of dikes was 4 to 30 feet, with a mean of 13.5 feet, and the mode was 12 feet (Fig. 4). Bottom widths generally were at least 28 to 30 feet. Average height was 6 to 7 feet.

There were 236 water control structures serving the managed impoundments. They varied in size, and 56 percent were constructed of wood, most commonly creosote-treated pine; 40 percent were of metal, and 4 percent were of concrete. Only 11 water control structures in good operating condition were made of cypress. Old cypress structures that had deteriorated had been replaced with pine or metal structures because of the scarcity of cypress.

Wooden water control structures were of a design similar to the original rice field trunks (Figs. 5-6). The flap gates at both ends could be raised or lowered to take in or let out water with the tides. If water was needed, the gate outside the pond was raised. At high tide the force of the water pushed open the inside flap gate. When the tides subsided, the pressure of the water in the pond against the inside flap gate caused it to close. When drainage was desired, the inside flap was raised on an outgoing tide, and the force of the outward rushing water pushed open the outside gate.

Most modern water control structures also had a flash-board riser just behind the inside mouth permitting water levels to be maintained at the desired level. The riser consisted of a rectangular trough built perpendicular to the inside lip of the trunk, usually about 5 feet high, 5 feet wide and 1 foot deep. The side of the trough facing the pond was made of removable boards ("flash-boards" or "riser-boards") placed horizontally in grooves that ran the height of the "riser". With the inner gate shut, the water level of the impoundment could be regulated by adding or removing boards. The

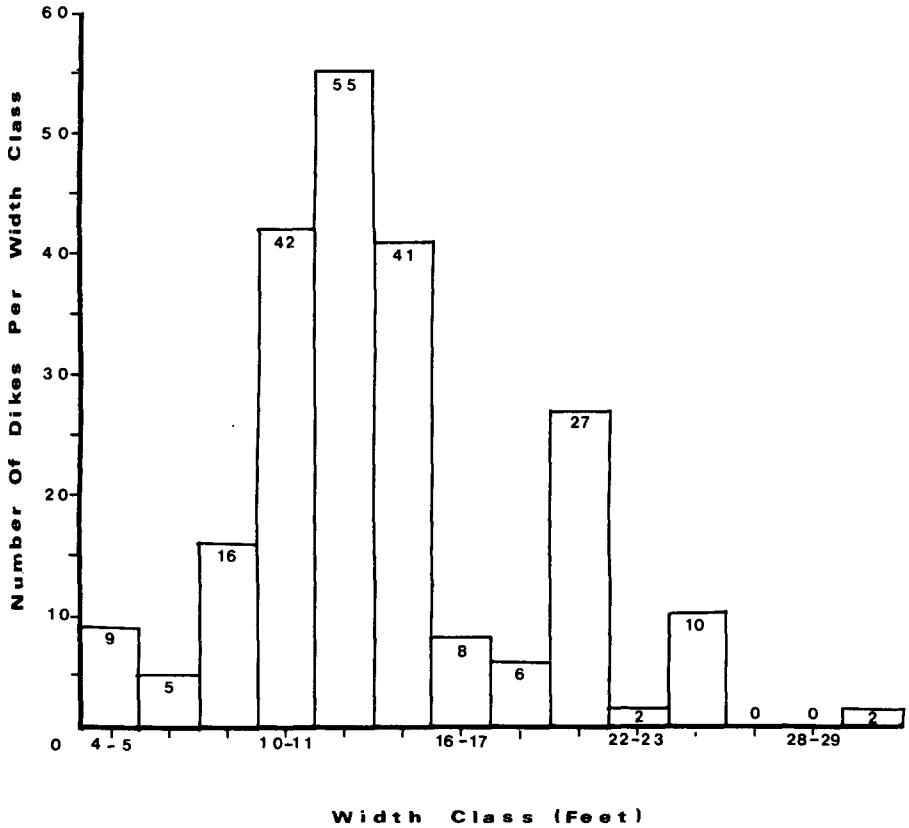

Fig. 4. Widths of 223 dike tops maintained within the South Edisto-Ashepoo-Combahee River System, 1972.

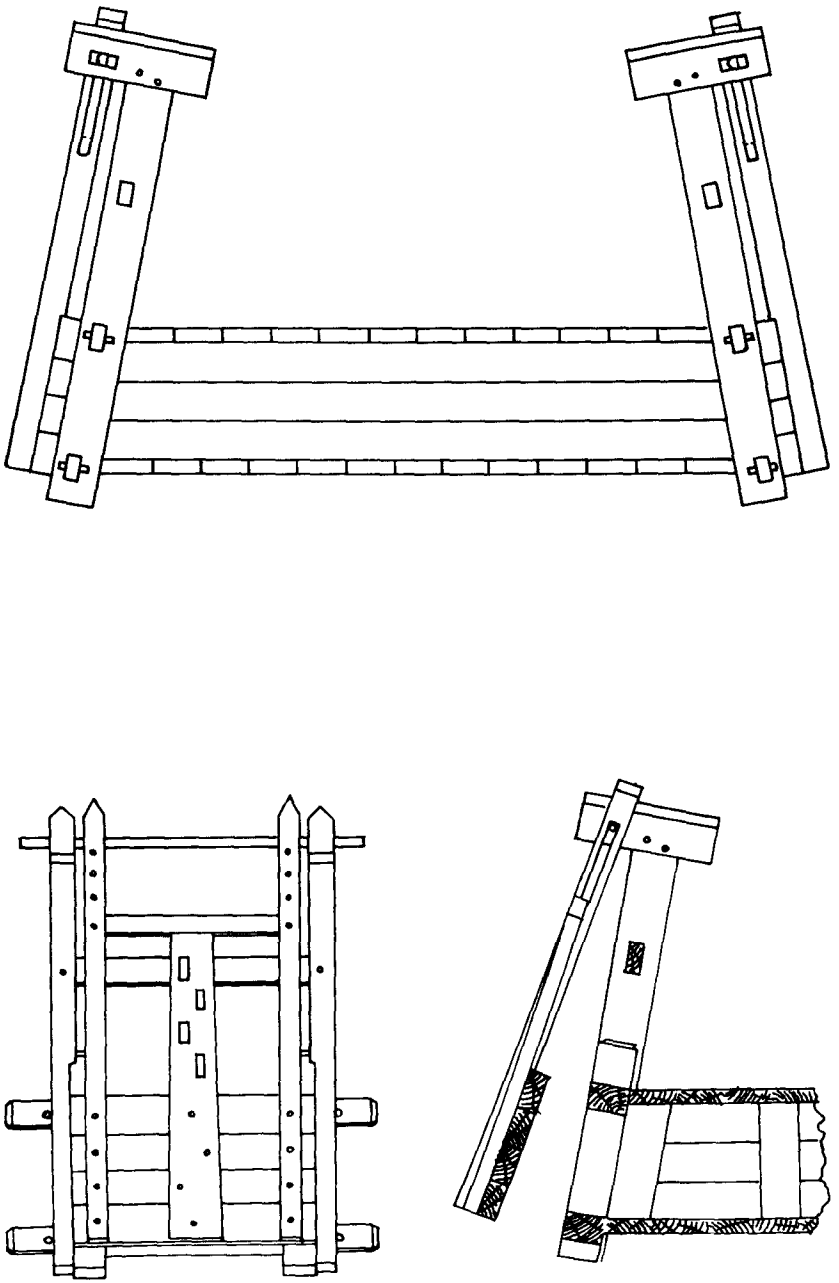

Fig. 5. Rice field trunk: top—full length side view; left—end view, loking at a flap gate; right—side view with flap gate open. (Redrawn from drawings by H. J. Garety *in* Doar 1936.)

Fig. 6. Typical water control structure being installed at the Bear Island Game Management Area.

flash-board riser served as an automatic spillway; when rains flooded a pond, the surplus water could be drawn off by manipulating riser-boards.

Metal water control structures were made of heavy gauge aluminum or steel with heavy bronze flap gates on each end; they worked on the same principle as the wooden structures. They often had metal flash-board risers with wooden flash-boards. Concrete pipe also was used with various wooden flap gates or flash-board risers attached. Also, a fiberglass flap gate on a concrete pipe was encountered. Most owners reported these modern structures less durable than the old style wooden structures.

Water control structures — wood, metal, or concrete — existed with many innovations. Some had two flap gates and a flash-board riser; others, only two flap gates. Often only one flap gate was used, and the mouth on the outside of the pond was open. Most commonly, wooden structures had two flap gates. The metal structure found most often was one with an outer flap gate and an inner flash-board riser. These structures were from 20 to 48 feet long, 1 to 5 feet wide and 1 to 4 feet deep.

Techniques of Vegetation Control

The usual objective in vegetation management was to alter various factors affecting plant composition so as to reduce the coverage of undesirable plants, usually coarse perennials, and favor increased production of desirable duck foods, usually emergent annuals or certain submerged aquatics. Various treatments were employed to accomplish this goal. These generally involved manipulation of water levels and salinities, and disturbance by burning, mowing, disking, or chemical weed control. These are among the management techniques most commonly used in coastal marshes of the South (Yancey 1964; Baldwin 1968, Neely, 1960, 1968). The frequency of use of these techniques is summarized in Table 1.

Table 1. Management treatments used on impoundments along the South Edisto, Ashepoo and Combahee rivers, 1972.

	South Edisto R.		*Ashepoo R.*		*Combahee R.*		*Totals***	
Treatment	*Ponds*	*Acres*	*Ponds*	*Acres*	*Ponds*	*Acres*	*Ponds*	*Acres*
Water manipulation*	22	4,480	26	2,138	42	5,053	90	11,671
Permanently flooded	6	123	18	1,235	26	2,146	50	3,504
Permanently drained	2	22	2	533	7	771	11	1,326
Burning	19	3,938	18	1,650	12	1,204	49	6,792
Mowing	4	460	2	57	11	405	17	922
Disking	4	414	5	108	6	139	15	661
Planting (summer drawdown)	3	172	0	0	5	261	8	433
Grazing	8	1,116	1	51	12	980	21	2,147
Herbicides	2	172	3	60	0	0	5	232

* Includes summer drawdown for growth of native annual plants and fluctuations for growing widgeon grass and saltmarsh bulrush.

** Some impoundments received more than one type of treatment, so the number of ponds and acres in these columns if summed will exceed the total for the study area.

Management included various modifications of the following basic systems of water control in conjunction with specific techniques such as planting, grazing and use of chemicals: (1) summer drawdown; (2) cyclic fluctuations of water levels during the growing season to encourage growth of salt-marsh bulrush *(Scirpus robustus)* and associated species; (3) slowly rising water levels to encourage growth of widgeongrass *(Ruppia maritima)*; (4) permanent flooding; and (5) permanent drainage for grazing. Numbers of ponds and acreages for each management system are given in Table 2.

Emergent vegetation in freshwater impoundments generally was managed by partial or complete drawdown during the growing season with various applications of fire, herbicides, mowing, disking, and grazing to control undesirable species such as cattail *(Typha* spp.) and giant cutgrass *(Zizaniopsis miliacea)* and encourage annual emergent duck foods such as smartweeds *(Polygonum* spp.), wild millet *(Echinochloa* spp.), panic grasses *(Panicum* spp.), and redroot *(Lachnanthes caroliniana)*. Generally, best results were achieved with soil disturbance. Water was normally drawn down in the spring after the ducks were gone and reflooded to about 12 to 18 inches in the fall. When the marsh bed was kept moist during the growing season and burning was practiced, large-seeded smartweeds were encouraged. Panic grasses, wild millet and flat sedges *(Cyperus* spp.) were also abundant. Redroot was a dominant plant only on peat marsh, where analysis of stomach contents (unpublished data) revealed it surpassed all other plants as pintail *(Anas acuta)* and mallard *(A. platyrhynchos)* food. Good redroot production was limited to one extensive area on the South Edisto River.

Well managed summer drawdown ponds usually wintered high populations of mallards, pintails, green-winged teal *(A. crecca carolinensis)*, and blue-winged teal *(A. discors)*, with some black ducks *(A. rubripes)*, gadwall *(A. strepera)*, shovelers *(A. clypeata)*, and others.

Cattle grazed in late summer and early fall on the wet beds of two impoundments on one property. The cattle grazed most heavily on undesirable plants such as giant cutgrass (young growth) and alligatorweed *(Alternanthera philoxeroides)* and avoided smartweeds, the most desirable duck foods. A moderate amount of trampling and grazing opened the vegetation and provided better feeding areas for ducks. Allan (1950) reported a similar system of coordinating grazing and waterfowl management in Louisiana.

Table 2. The number of impoundments and acreages by management system in the tri-river study area, 1972.

Management System	South Edisto R.		Ashepoo R.		Combahee R.		Total	
	No. Ponds	Acres	No. Ponds	Acres	No. Ponds	Acres	No. Ponds	Acres
Fresh Water								
Permanently flooded:								
pond	11	1,177	26	1,313	30	1,904	67	4,394
backwater	0	0	0	0	1	169	1	169
Summer drawdown:								
volunteer plants	15	3,458	4	62	9	1,881	28	5,401
grazing	4	460			9	724	13	1,184
crops	1	2	1	55	5	264	7	321
Planted cypress	2	200	0	0	0	0	2	200
Permanently drained:								
volunteer plants (grazing)	2	22	0	0	2	506	4	528
crops (cattle)	0	0	1	51	0	0	1	51
Brackish								
Permanently flooded*	19	2,331	30	2,710	27	2,575	76	7,616
Fluctuating water level**	1	222	3	843	8	976	12	2,041
Permanently drained***	2	634	0	0	0	0	2	634
Total	57	8,506	65	5,034	91	8,999	213	22,539

* Includes mostly widgeon grass ponds. These ponds are drained only once every two or three years for a short time for water quality and pest-plant control. Normally the water levels are gradually raised during the growing season.

** These ponds are drained and water levels are increased gradually to follow the growth of saltmarsh bulrush. Various water level fluctuations are often involved.

*** Used exclusively for cattle grazing.

A more typical system of coordinated grazing and waterfowl shooting involved drawing water well below bed level to thoroughly dry the marsh. Cattle then grazed in the drained impoundments during the growing season, and the marshes were flooded in the fall for duck shooting. The marsh vegetation was burned, usually in late winter. Major duck foods on these thoroughly drained marshes were panic grasses and flat sedges. Although grazing schedules varied, good production of duck food was assured only when cattle were removed by mid-August so that plants such as fall panic grass *(Panicum dichotomiflorum)* could mature seed before duck season.

Snipe fields were managed much as summer drawdown impoundments but were flooded only to bed level, and beds were mounded so that waters tended to puddle. The beds of most snipe fields were disked periodically to keep soils loose for snipe feeding. Snipe field management commonly was coordinated with cattle grazing.

Permanently flooded freshwater impoundments, excepted managed fishponds, were generally under low intensity management and were used for waterfowl sanctuaries, water reserves, fish ponds (unmanaged), and duck shooting. Permanently flooded impoundments generally provided conditions for growing only fair duck food plants, such as water-shield and proliferating spikerushes *(Eleocharis* spp.). Five freshwater ponds comprising 579 acres were permanently drained for cattle grazing (Table 2).

Brackish or saline impoundments were typically managed for widgeongrass or salt-marsh bulrush depending upon elevation of the marsh and to some extent salinity of available water. In the deeper impoundments widgeongrass was generally the object of management. During the growing season, water was slowly raised to encourage maximum growth. Some ponds were above mean high tide, so water was taken in on spring tides. Ponds were drained every two years or as necessary to remove stained water and often were burned before reflooding. Salinities were kept at 25 to 50 percent sea strength when possible to discourage competing vegetation. The main duck species wintering on widgeongrass ponds were wigeon *(Anas americana)*, gadwall, scaup *(Anas marila* and *A. affinis)*, blue-winged teal and green-winged teal.

In shallower ponds salt-marsh bulrush was commonly the object of management. Management procedures for this species varied greatly between properties, but the most successful management

involved fluctuating water levels three to five times during the growing season, somewhat as described by Neely (1960), to lessen competition from undesirable perennials such as big cordgrass *(Spartina cynosuroides)* and saltwater cattail *(Typha domingensis)*. Water was drawn down in February or March, and every two years (or when needed) ponds were dried and burned to reduce debris buildup. Widgeongrass was an important food producer in potholes and canals in salt-marsh bulrush ponds as was dwarf spikerush *(Eleocharis parvula)*, which grew around the edges of the ponds. Salt-marsh bulrush ponds attracted mainly wigeon, teal, mallards, black ducks, pintails, and some shovelers.

Poorly managed or unmanaged brackish impoundments that remained permanently flooded produced very little of these important foods and were dominated by floating mats of filamentous algae *(Cladophora* spp.) in the deeper areas and *Spartina* spp. and *Juncus* spp. in the emergent zone. Such areas wintered relatively few ducks of mixed species.

Cattle were not grazed within brackish impoundments, only on the edges. However, two diked areas composing 634 acres in the salt water zone, had been permanently drained for pasture (Table 2). Some property owners allowed cattle to graze in the higher zones of the undiked tidal salt marsh.

Hunting

Hunting pressure on most private marshes was moderate, and many ponds served as waterfowl refuges during part of the winter. Data collected in the field and from questionnaires indicated that most landowners hunted twice a week for 14 hunts a season. The number of hunters per hunt was directly dependent upon the size of the impoundment. Normally, ponds were not hunted more than once a week, but some of the large impoundments were hunted 1.5 to 2 times per week. Practically all hunting was during morning hours.

Landowners interested in waterfowl generally shot within legal bag limits. Most landowners used retrievers, and some would not allow hunting unless retrievers were used. The average crippling loss reported was 13 percent; 35 percent was the highest reported. Crippling losses reported by those who always used retrievers averaged 7 percent as compared with 18 percent reported by those who used retrievers only some of the time.

Some marsh owners had problems with poachers shooting ducks in the impoundments from the rivers. These disturbances occurred infrequently, and generally the ducks on privately managed impoundments in the study area were not harassed.

Legal public shooting occurred along the creeks and rivers, and there were regulated public hunts on Bear Island Game Management Area.

Harvest and Returns from Management

Calculations of hunting pressure and harvest of ducks from managed impoundments were based on detailed records maintained by owners or managers of six private properties and the Bear Island Game Management Area. Estimates provided by owners of other properties who did not keep detailed records agreed closely. These data showed an average of 0.18 man-days hunting per acre of managed impoundment per year, yielding an annual harvest of 0.6 ducks per acre of impoundment managed for waterfowl. Projected, these figures provide an estimate of 3,432 man-days of hunting and 11,438 ducks killed in all impoundments managed for waterfowl during the 1972-73 season, an average of 3.3 ducks per man-day. The number of man-days of hunting per acre was approximately the same for the Bear Island Game Management Area and private areas. However, average harvest on privately managed areas (0.7 ducks per acre) was higher than on the Bear Island Game Management Area (0.5 ducks per acre).

There were 2,020 cattle grazed on 2,461 acres of diked wetlands or permanently drained wetlands being used for pasture. A total of 408,825 grazing days annually was provided by diked impoundments.

Costs of Management

The major capital investment in developing diked impoundments was the dikes and associated water control structures. Capital values for these investments were based on replacement costs. According to interviews with drag-line operators who constructed and repaired dikes in the study area, the cost of building an average dike (7 feet high, 12 feet wide at the top, and 30 feet wide at the base) was $1.65 per linear foot if built on stable soils. This cost included a second trip or "pass" around the dike. Often two years after a dike was built, a third "pass" was needed to bring the dike up to grade, at an additional cost of $1.25 per linear foot. The average total cost per linear foot of dike was estimated to be $2.00.

Cost figures from drag-line operators and individuals who built water control structures were used to calculate replacement costs for all such structures in the study area. Costs of wooden structures 2 feet high, 5 feet wide and 35 feet long with two flap gates and one flash-board riser were $2,290 each. Replacement costs for metal structures, 36 inches in diameter and 36 feet long with two bronze flap gates and one flash-board riser, were $1,460 each. Replacement costs for smaller, simpler structures ranged from $495 to $875 each.

A replacement cost of $1,920 for the ten concrete water control structures in the study area was determined from cost lists of concrete pipe companies in the Charleston area.

Estimates of annual costs were based on maintenance of dikes and water control structures, habitat manipulations and taxes. Only labor directly related to these operations is included; labor costs for mowing dike vegetation and for maintenance of access roads, barns, storage buildings, and equipment and other indirect labor costs are not included.

The average interval between dike retopping was 6 years, with some landowners retopping at 2 years and others at 10 years. An average cost of $1.25 per linear foot for retopping was estimated from interviews with drag-line operators. Continually sinking dikes or numerous bad breaks increased this cost considerably. Another dike maintenance cost was mowing, but no estimate of this was made.

Records provided by landowners indicated the annual maintenance cost per water control structure to be $72.00 with replacement being necessary at about 20 years.

Annual cost of habitat manipulation within impoundments, including flooding, burning, water level manipulation, disking, plowing, planting of commercial crops, cattle grazing, and herbicide application ranged from $1.85 to $17.44 per acre per year, with most owners reporting costs between 7 and 11 dollars per acre. The average cost of annual habitat management for privately managed areas was $8.25 per acre compared with $8.55 per acre for the Bear Island Game Management Area. The annual cost of habitat management per acre of impoundment depended on the ecological situation, intensity of management, management goals, and the amount of capital an owner was willing to invest. There was much variation in operational costs, and simple averages of management and maintenance costs are misleading; each property had peculiarities that made it unique.

The tax assessor from each county in the study area furnished information on 1973 property taxes. The property tax for each 100 acres of wetlands was as follows: Charleston County—$11.56; Colleton County—$37.10; and Beaufort County—$5.10

Cost per Wildlife Benefit Unit

The costs, capital and annual, given above were used to construct a model cost table for 100 acres of diked impoundment over a 20-year period (Table 3). The values in Table 3 are averages, and actual costs will vary with the situation.

Table 3. Average cost of managing 100 acres of diked impoundment in the tri-river study area.*

Cost Category	*Capital Cost*	*Annual Cost*	*Total Capital and Annual Cost***
Dike construction	$7,340		$ 748
Water control structures (wooden)	2,290		233
Maintenance			
dikes		$ 764	764
water control structures		72	72
Habitat manipulation		852	852
Taxes (Colleton County)		37	37
Total	$9,630	$1,725	$2,706

* Does not include costs of land, estate labor, facilities and equipment which are primarily used in management of uplands.
** Annual cost plus capital cost annualized at 8 percent for 20 years.

Based on an extrapolation of data in Table 3, total annualized cost for the 19,064 acres of diked impoundments managed for waterfowl was $515,872. From this figure and the estimated annual harvest of 11,438 ducks, the cost per duck harvested was $45. From the same cost figure and the 3,432 man-days of hunting previously calculated, the cost per man-day of hunting was $150. For those impoundments in which cattle were grazed, management costs may be reduced by returns from the grazing provided.

The financial investment in the management of diked impoundments for the entire study was a large sum. Capital value (based on replacement cost) of all functioning dikes and water control structures in the area was calculated to be $2,048,774. Total annualized costs of management of diked impoundments managed for wildlife was $530,836 and for all impoundments was $609,824, including $22,777 in property taxes.

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